Miss Rosseare

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BULLETIN No. 18

Pastures and Forage Crops in South Africa

ABERYSTWYTH, OCTOBER, 1936.

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PASTURES AND FORAGE CROPS IN SOUTH AFRICA

Contributions by

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S. R. de Villiers

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INTRODUCTION.

The grasslands and forage crops of the British Dominions and Colonies have been dealt with in various issues of the Herbage Publication Series. Research in New Zealand was covered in Bulletin No. 11, and research in Australia in Bulletin No. 14 and in *Herbage Reviews*. Papers on research in India have app ared in *Herbage Reviews* and a series of Canadian articles is at present running in the same Journal. It is with great pleasure, therefore, that the Herbage Bureau now publishes this Bulletin on the research in pastures and forage crops in the Division of Plant Industry of the South African Department of Agriculture.

Reference may also be made to other publications giving accounts of research in South Africa. These are the University of Pretoria Bulletin, Series 1, No. 23. 1932, entitled "The grasslands of South Africa," the article by T. D. Hall on "South African pastures: retrospective and prospective," *S. Afr. J. Sci.* 31. 59-97. 1934, and a more recent Bulletin from the University of Pretoria (Series 1. No. 36. 1936) entitled, "Grassland development in South Africa," by R. Lindsay Robb.

R O. WHYTE.

PASTURE RESEARCH IN THE UNION OF SOUTH AFRICA.*

I. B. Pole Evans.

Chief, Division of Plant Industry, Department of Agriculture, Pretoria.

The Union of South Africa covers some 470,000 square miles. The Union's northern boundaries extend beyond the Tropic of Capricorn while its southern shores are exposed to the waters from the Antarctic. Such a tract of country might reasonably be expected to show considerable diversity of climate, topography, vegetation and soils, and this actually is so. Diversity of vegetation implies different types of pasturage.

The Natural Pastures of the Union.

In the Union the natural pastures are of four distinct types, namely, parkland, grassland, desert shrub, and sclerophyllous bush. Parkland covers the northern and central portion, grassland the eastern portion, desert shrub occurs over the greater part of the western portion, while sclerophyllous bush occupies the south western corner.

The grassland and parkland areas are essentially those of spring and summer rainfall, the desert shrub area receives most of its rain in autumn, while sclerophyllous bush falls within the winter rainfall belt. The eastern half may, therefore, be described as a grazing area, while the western and south-western portions are almost purely browsing areas. Cattle predominate in the parkland and grassland areas, while sheep and goats are the principal stock reared in the desert shrub and sclerophyllous bush areas.

The Sclerophyllous Bush Region.

The sclerophyllous bush area now contains very little grass in the form of a sward, but a great variety of grasses occurs sparsely scattered through the bush. The common ones belong to the genera *Cymbopogon, Hyparrhenia, Themeda, Pennisetum, Stenotaphrum, Cynodon, Koeleria, Avenastrum, Pentaschistis, Pentameria, Danthonia, Aristida, Ehrharta, Melica, Lasiochloa, Brizopyrum* and *Agropyrum*. The vegetation has been so maltreated by man and his animals that radical changes in the vegetal cover have been brought about. Although the region has been settled for over 250 years, it is remarkable that even to-day very little is known of the browsing or grazing value of the plants composing the vegetation. The area is largely devoted to the production of deciduous fruit, wine and winter cereals. There are in certain parts great possibilities for the establishment of artificial pastures under irrigation, especially for Kikuyu grass (*Pennisetum clandestinum*) and clovers, but few of the farming community have as yet realized the value of permanent pastures as compared with cash crops.

The Desert Shrub Region.

The desert shrub region, including the karroos, Bushmanland and Namaqualand, has been the venue of countless hordes of small stock—sheep and goats—since the early occupation of the Cape. The land has been stocked to overflowing with ever-increasing intensity, resulting in removal of vegetation, trampling of ground and washing away of soil. Reed-lined rivers no longer exist and a general lowering of the

*Paper read at the Imperial Botanical Conference, London, August, 1935.

water table due to rapid run-off and run-away has increased still more the natural arid and desert conditions.

Apart from the sandy wastes of Bushmanland, little of this country is occupied by perennial grasses, but frequently, after periods of drought followed by heavy rains, large parts may become covered by a dense growth of annual grasses, composed largely of the genera *Aristida, Eragrostis, Chloris, Schmidtia, Enneapogon, Schismus* and *Tragus*. Most of these are of low nutritive value after seeding, and add little to the carrying capacity of the veld. The staple pasturages of the region are the desert shrubs. Here also, until quite recently, little was known of the actual value of these different shrubs to the browsing animal, and less still was known of the effect of the browsing animal on the plant, although the region has been heavily exploited from the earliest days of white settlement.

THE PARKLAND REGION.

North and east of the desert shrub region lie the great parkland and grassland regions. The central portion of this region is occupied by the great Kalahari desert, whose vegetation, composed largely of thorn country, has made several deep invasions into the grassland and parkland country to the east.

So far as the Union of South Africa is concerned these eastern extensions of the thorn country of the Kalahari form most important and valuable ranching country, namely, the Bechuanaland and Transvaal bushvelds.

The thorn country of the Kalahari is anything but a desert in the generally accepted meaning of the term. In the south and south-west it is composed of sandy plains and dune covered country richly clothed with grass and occasional thorn bush and tree; further north orchard country of *Acacia* and *Boscia* occurs, while still further north the vegetation merges into parkland and dry forest. The pastoral value of the thorn country of the Kalahari is largely limited by the lack of watering facilities and the sandy nature of the soil. Perhaps it is just as well that this lack of watering facilities exists, as otherwise it would now have been reduced to a pure sandy waste. Few have realized that in arid climates natural grazing lands deteriorate very rapidly unless they are most carefully handled. Nowhere is this more evident than in the thorn country now under review.

The south-eastern extension of the thorn country of the Kalahari forms what is known as the Bechuanaland bushveld. This has long been regarded as some of the best cattle raising country in the Cape Province, but it met with the same treatment as was meted out to the desert shrub region. It was soon overstocked beyond its carrying capacity, and veld deterioration, resulting in mineral deficiency of the pasturage with accompanying animal disease, soon set in. It was the investigation of this disease by Theiler that formed the starting point of the mineral analysis of South African pasturage by Henrici and the carrying capacity tests of various South African grasses by myself.

The Bechuanaland bushveld consists of typical thorn country with more or less open grassland with scattered bush. The dominant grasses are *Themeda, Anthephora, Schmidtia, Fingerhuthia, Eragrostis, Rhaphis, Digitaria* and *Aristida*.

The rainfall over the area varies from 15 - 20 inches, most of which falls in summer during thunderstorms. The dry period may last for six or more months, so that there is often a long dormant period. On the whole the grasses in this area are deficient in phosphorus and have a low protein content, and the value of the pasturage depends largely on the amount of *Digitaria* and *Rhaphis* which are present. Both these grasses have a high phosphorus content compared with the others and also a high crude protein content. By careful management it is possible in this area to produce almost pure Digitaria pastures by correct methods of grazing.

The north-eastern extension of the thorn country of the Kalahari comprises the Bushveld of the Transvaal, which is in fact the ranching country *par excellence* of the Union.

The Transvaal Bushveld is composed of flat undulating country lying between 2,500 and 4,000 feet above sea level. It is covered by bush and tree with more or less luxuriant grass. The dominant trees and bush belong mostly to the genus *Acacia* and the vegetation may be described as typical thorn country. A great variety of grasses occurs, their distribution being closely associated with the different soil types. On the whole the grasses are of high feeding value, especially those belonging to the genera *Panicum, Urochloa, Digitaria, Brachiaria, Setaria, Pennisetum* and *Chloris*.

The average rainfall over the area is from 15 to 25 inches. Slight frosts occur over a period of 25 to 50 days, but the climate on the whole is warm and the evaporation is great. A layer of calcium carbonate below the surface soil is fairly general throughout the area. Provided there is sufficient grazing cattle remain remarkably fat and sleek throughout the winter.

The north-western extension of the Bushveld merges gradually into the Lowveld of the Limpopo Valley and then extends eastwards and southwards into the Lowveld of the north-eastern Transvaal, Swaziland and Zululand. The vegetation of the Lowveld is dry thorn forest with a more or less scanty growth of annual and perennial grasses. Over the northern portion the rainfall rarely exceeds 15 inches and frequently is much less. Over the eastern portion it varies from 15 to 30 inches, but the erratic nature of its fall, combined with the great heat, rapid evaporation, and long drought periods, render the country fit for ranching to a very limited extent only. The dominant grasses of the lowveld belong to the genera *Aristida, Enneapogon, Schmidtia, Anthephora, Themeda, Panicum, Urochloa, Digitaria, Hyparrhenia* and *Cymbopogon*. Ever recurring droughts throughout the Lowveld make ranching and stock farming very hazardous propositions in these areas and more often than not the farming community becomes a burden on the State. It is in the Lowveld that the Government has set aside the great Kruger National Park, an area of some 7,800 square miles in extent. This has proved to be one of the most valuable assets of the country, both as regards tourists from overseas and as an attractive holiday resort for the citizens of South Africa.

The most valuable ranching country of the Lowveld occurs in Zululand and Swaziland, but unfortunately the presence of tsetse fly in Zululand considerably restricts full use being made of it.

The remaining portion of the Union's parkland country is occupied by high-lying country known as the Limpopo Highlands, and by a stretch of mountainous and broken country bordering the Bushveld in the south known as the Banken Veld.

The Limpopo Highlands, which protrude into the Bushveld to the south-west and abut on the Lowveld to the north and east, are a composite region of closed forest, parkland, grassland and thorn country. They experience a wide range of rainfall (15 to 70 inches) and slight frosts occur over the southern portion only. They can be divided into four well marked areas :—the Waterberg plateau, the Pietersburg plateau, the northern Drakensberg, and the Zoutpansberg. The Waterberg plateau consists of parkland and orchard country of evergreen and deciduous trees and bush with a mixed grass flora in which, for the most part, coarse unpalatable grasses predominate. The common grasses are *Themeda, Elyonurus, Schizachyrium, Heteropogon, Brachiaria, Hyparrhenia, Enneapogon, Pogonarthria, Trichopteryx, Triraphis, Xyochlaena* and *Digitaria*.

The Pietersburg plateau is made up largely of orchard country in which thorn,

VEGETATION MAP OF SOUTH AFRICA

Map adapted from that accompanying Botanical Survey Mèmoir No. 15, 1935, by I. B. Pole Evans, published by the Department of Agriculture and Forestry of the Union of South Africa.

KEY TO VEGETATION TYPES

FOREST

Evergreen and deciduous bush and subtropical forest ..... Type 1

Temperate evergreen forest ..... (Type 2)

Evergreen sclerophyllous bush ..... Type 3

PARKLAND

Evergreen and deciduous tree and bush ..... Type 4

Subtropical evergreen and deciduous tree and thorn forest ..... Type 5

Thorn country ..... Type 6

GRASSLAND

Tall grass ..... Type 7

Short grass ..... Type 8

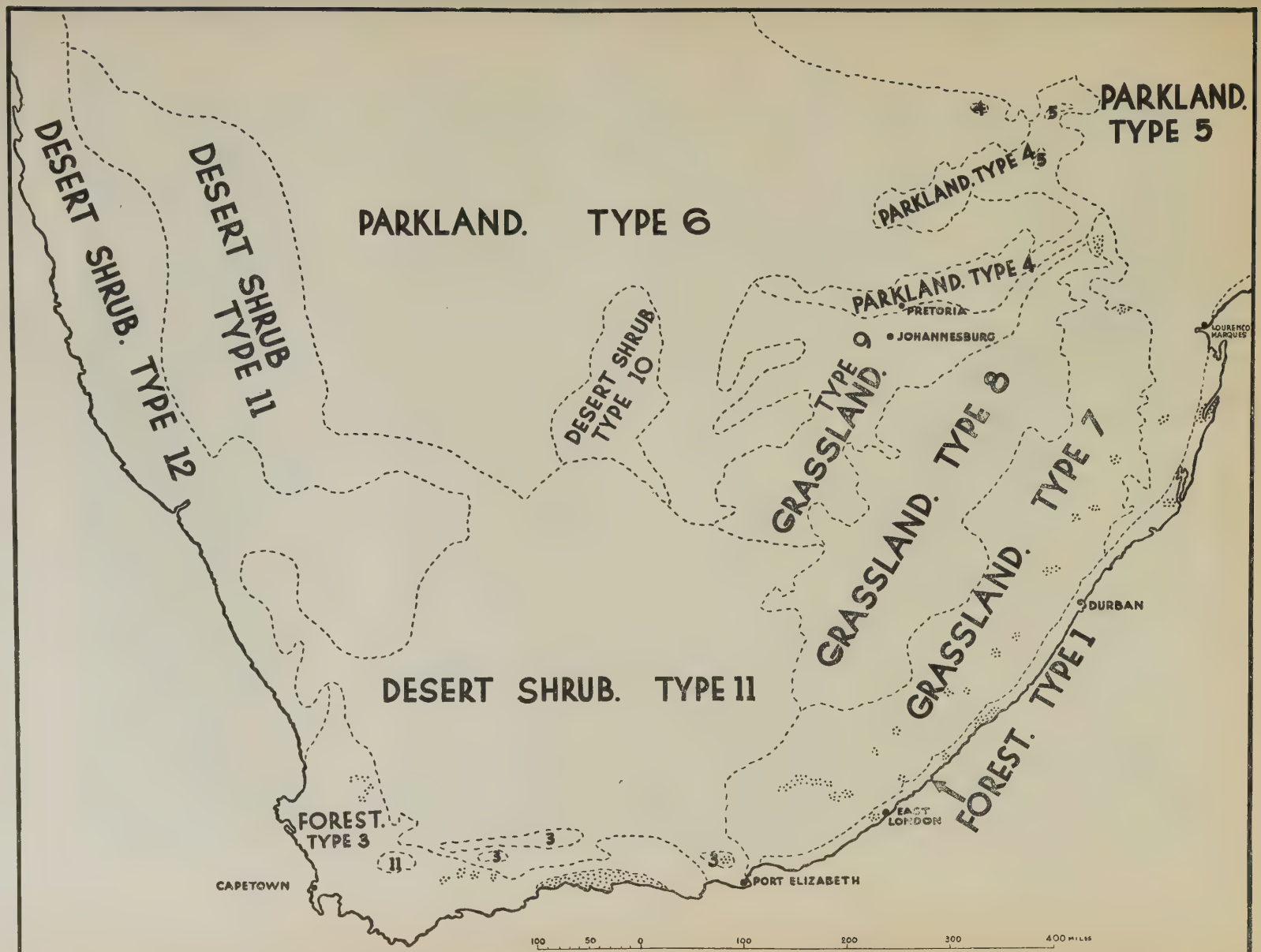
Mixed grass ..... Type 9

DESERT SHRUB

Thorn country and desert shrub ..... Type 10

Desert shrub ..... Type 11

Desert succulents and desert grass ..... Type 12


PARKLAND. TYPE 5
PARKLAND. TYPE 4.5
PARKLAND. TYPE 6
PARKLAND. TYPE 4
PRETORIA
JOHANNESBURG
LOURENCO MARQUES
DESERT SHRUB. TYPE 12
DESERT SHRUB TYPE 11
DESERT SHRUB TYPE 10
GRASSLAND. TYPE 9
GRASSLAND. TYPE 8
GRASSLAND. TYPE 7
FOREST. TYPE 1
DURBAN
DESERT SHRUB. TYPE 11
FOREST. TYPE 3
EAST LONDON
CAPETOWN
PORT ELIZABETH
100 50 0 100 200 300 400 MILES

deciduous tree and arborescent Euphorbias are conspicuous. The dominant grasses are *Themeda, Hyparrhenia, Cymbopogon, Digitaria, Setaria, Panicum, Eragrostis* and *Urochloa.* These yield pasturage of good quality throughout the year, and this area is one of the best pastoral areas in the northern Transvaal.

The northern Drakensberg is composed of patches of evergreen forest, mountain grassland and parkland country of deciduous and evergreen trees. On the eastern slopes of the Drakensberg a tall rank growth of grass occurs in which the genera *Cymbopogon* and *Hyparrhenia* are the dominating feature. On the steeper slopes *Themeda triandra* is dominant and in the vicinity of bush *Panicum maximum* and *Setaria sulcata* largely compose the grass cover. The mountain grassland is made up of a dense sward of *Cymbopogon, Hyparrhenia* and *Themeda.*

The grazing in the northern Drakensberg is, on the whole, of poor quality. Owing to the high rainfall the soils are leached, and the nutritional value of the pasturage is consequently low. The area, however, offers considerable scope for the laying down of artificial pastures, and successful results have been obtained in this direction with Kikuyu, *Digitaria,* and Napier grass (*Pennisetum purpureum*) pastures.

The Zoutpansberg is one of the most interesting and remarkable vegetation areas in the Union. Not only does it contain a wealth of vegetation growth forms, but it also still remains a sanctuary for many botanical relics of the past. It displays a wonderful diversity of vegetation types, all almost within a stone's throw of each other. Tropical forest, temperate evergreen forest, parkland, thorn country and tropical desert shrub all occur here. Tall mesophytic grasses belonging to the genera *Cymbopogon, Hyparrhenia* and *Themeda* dominate the southern and south-eastern slopes and valleys, while xerophytic and annual grasses such as *Aristida, Chloris, Digitaria, Dinebra, Eragrostis, Pogonarthria, Enneapogon, Schmidtia* and *Tricholaena* occur on the northern slopes.

The southern and south-eastern portions afford good pasturage throughout the year, but the northern portion which merges into the Lowveld yields intermittent and scanty grazing.

The Banken Veld which lies between the Bushveld and the mixed grass country of the Middle Veld is typical orchard country vegetation composed of evergreen and deciduous tree and bush and coarse grasses mostly of poor grazing value. The veld is known locally as sour veld. The soils throughout the area are mostly sandy and are distinctly acid. The rainfall over the area varies from 25-40 inches, most of which falls in the summer months during thunderstorms. The dominant grasses belong to the genera *Themeda, Hyparrhenia, Elyonurus, Tristachya, Trichopteryx, Aristida, Trachypogon* and *Urelytrum,* all of which afford grazing of low nutritive value.

THE GRASSLAND REGION.

Lying between the parkland country to the north and west and the desert shrub country to the south are the true grasslands of the Union. They occupy the larger portion of the eastern half of the sub-continent and experience a rainfall varying from 20-40 inches. The central portion of this grassland region is composed of high-lying country (5,000 to 6,000 ft.) covered with short grass with deciduous herbs. It is known locally as the Highveld. It yields early grazing in spring and summer, but is subject to early frosts and severe cold in winter, when the grazing provides pasturage of low nutritive value. *Themeda triandra* is the dominant grass in this association, and develops under a rainfall of 25 to 30 inches.

West of the High Veld lies an irregular tract of country—the Middle Veld—a grassland association of very mixed composition. The Middle Veld is in reality the

meeting ground of grasses from the west, east, north and south. In years of low and erratic rainfall, the western and southern grasses assume dominance, while in years of abnormally high rainfall, eastern and northern forms are conspicuous. The dominant grasses belong to the genera *Themeda, Cymbopogon, Hyparrhenia, Tristachya, Trichopterix, Digitaria, Anthephora, Aristida, Eragrostis, Urelytrum* and *Trachypogon.*

The rainfall over this area varies from 15-25 inches, most of which falls during thunderstorms and is of a variable and erratic character.

Grass is the dominating feature of the Middle Veld, but whenever the country is broken scattered trees and bush occur. Thorn bush is frequent in the broken country to the north and in the drier valleys to the south and west.

Frosts are frequent over the whole area and extend over a period of 50 to 150 days. The uncertain rainfall, combined with early and late frosts, and the mixed composition of the grassland render the area, on the whole, one of only moderate pastoral value.

East of the High Veld is a wide stretch of country which slopes from the great eastern or Drakensberg escarpment almost to the Indian ocean. This tract of country is covered mainly by tall grass and is known as the Eastern Grassland. It enjoys a higher (30 to 40 inches) and more certain rainfall than the High Veld and also experiences a more equable climate. It is well watered with permanent streams and once possessed well timbered forests in the seaward kloofs and valleys. The country throughout is largely occupied by Native tribes, who long ago realized the value of the pasturage for their flocks and stock.

This area offers the greatest possibilities of any region for intensive farming in the Union. Much of the area is well suited to the laying down of artificial pastures and at present a colossal wastage of valuable pasturage is brought about through lack of grazing management and through burning. *Hyparrhenia hirta* is the dominant grass throughout this area and it yields good grazing under proper management, as well as valuable hay.

The Eastern Grassland includes what is known as the Native Territories (the Transkei, Tembuland and Pondoland), Natal, Swaziland and Zululand. In fact it carries the largest Native population in the Union.

Lying between the Eastern Grassland and the sea is a narrow coastal strip of country covered by dense bush, rank grass and occasional semi-tropical forest. The area is known as the coastal bush. The rainfall varies from 30 to 50 inches and is fairly regular in distribution. The soils are mostly sandy and yield a rank growth of grass which is remarkably deficient in phosphorus and poor in protein, but rich in sodium chloride. The dominant grasses belong to the genera *Cymbopogon, Hyparrhenia, Panicum* and *Digitaria.*

The region offers great possibilities for artificial pastures, provided fertilizers are used; Kikuyu grass has proved highly successful.

INFLUENCE OF MAN AND STOCK ON THE VEGETATION.

The above is a brief account of the Union's pastoral vegetation. Since the date of the country's occupation by a European population this vegetation has been sorely taxed by man and his ever-increasing herds and flocks, so much so that drastic changes have been brought about both in the general appearance of the country and in its water resources. In the sclerophyllous bush area of winter rain and summer drought, fire has played a most disastrous part. There has been a constant destruction of forest, bush and scrub, mainly to provide spring or early grazing. The result has been the steady removal of vegetation and soil from mountain slopes with the consequent diminution of springs; the plains and valleys have been re-

clothed with worthless shrublets, whilst along the coast a steady invasion of sand dunes is taking place.

In the desert shrub area most of the palatable shrubs have been destroyed through constant overstocking, vleis and reed-lined river banks have been tramped out and no longer exist, while sheet and gully erosion have taken place to such an extent that the water table has been considerably lowered.

In the thorn country and grasslands to the north and east, a steady invasion of unpalatable desert shrubs from the south is taking place. On the east coast the dense subtropical bush of Zululand and Natal is in many places being enveloped in sand dunes, whilst fertile hill slope and forest valleys are being stripped of grass and forest covering and their soil deeply eroded.

Throughout the tall grass country, from the Drakensberg escarpment almost to the coast, an annual removal of grass through fire takes place, and where there are stock paths and cultivated lands on slopes, and where overstocking is practised, the ground becomes deeply eroded.

In the short grass country on the great inland plateau the grass has been so overtaxed through continuous grazing that its pristine vigour has been sapped; it can no longer hold its own in the struggle for existence and is now giving way to deep-rooted unpalatable grasses and noxious weeds. Here too removal of the vegetation cover is invariably followed by severe erosion.

In the thorn country and thorn forest no less striking changes are to be observed. Palatable and nutritious grass is being replaced by deep rooted thorn bush and impenetrable thicket.

The above are some of the major results following the white man's colonization of the country and the subsequent segregation of the Natives to definite areas. These latter areas are to-day the real eyesores of the country and call for serious consideration. Unfortunately they were confined almost entirely to the most fertile parts of the grassland and parkland regions from which much of the soil and its vegetal covering have been removed.

Soon after the early occupation of this grassland and parkland country by Europeans a definite practice with regard to grazing was in vogue. The summer months were spent on the short-grass country of the High Veld; with the advent of winter everyone trekked with their stock and flocks to the thorn country for warmth and better grazing. This state of affairs continued until further introduction of stock from beyond the Union brought with it diseases. To combat this farms were fenced, movement of stock prohibited, and dipping introduced. These measures were so successful that remarkable increases in the number of stock took place within a comparatively short period of time. Within 25 years (1904-1929) cattle increased from three and a half million to over ten and a half million, and sheep from sixteen million to forty-five million.

Restriction of the movement of stock on account of disease, coupled with greatly increased numbers, naturally led to more intensive stocking, accompanied by its associated evils of overgrazing and erosion. Such intensive farming soon brought home to farmers the need for better pastures as reserves for the winter and times of drought. The losses from drought were colossal. During a period of 15 years (1917-32) over forty-one million sheep, goats, and cattle were lost through drought and insufficient grazing. This led to an effort on the part of the Department of Agriculture to improve the pastures of the country by the introduction of pasture grasses from Europe, America and elsewhere. Farmers desired in particular a grass that would remain green and succulent during the dry winter months. In the search for such grasses and in their introduction, Burtt Davy did yeoman service, but in spite of all efforts few exotic grasses have been able to withstand the rigours

of the South African climate and our grazing conditions. After this work was begun at Pretoria on the value of the indigenous grasses, particular attention being paid to their individual carrying capacity. At the same time Theiler had begun to suspect the mineral deficiencies of some of our natural pastures and under his direction Henrici started systematic work on the composition of different veld types with regard to obscure animal diseases in those areas.

In this connection every credit must be given to Theiler, Green and du Toit, who were the first to demonstrate the low phosphorus content of our soils with a corresponding low phosphorus level in the natural vegetation, below the physiological optimum requirement of cattle grazing over such areas.

RESEARCH IN VELD MANAGEMENT.

The realization of the importance of paying more attention to our veld flora was the means in 1918 of bringing into being a Botanical Survey for the Union. Among the chief aims of this Survey were :—

> " To study the vegetation in its relation to agricultural and pastoral development with special reference to veld-burning, overstocking, cultivation, manuring, drainage and irrigation."
>
> " To study the vegetation in particular in its relation to the unsolved stock diseases of South Africa, and thereby extend our knowledge of the poisonous and medicinal plants of the country."

The Survey was soon the means of bringing home to its members the rapid changes for the worse which were taking place in the veld as the result of general overstocking. The creation of veld reserves in different parts of the country was advocated for the special purpose of studying these problems and at the same time of demonstrating to the farming community what might be achieved by resting the veld. Reserves were established in the northern Transvaal, in the Cape, and in the Free State, but they were looked upon by the authorities with little enthusiasm and received scant support, with the exception of the Fauresmith Reserve in the Free State, where a fully equipped laboratory was established in 1926, and where valuable pioneer work on the investigations of desert shrub as pasturage has been done.

In the meantime the preliminary work begun at Pretoria on the actual carrying capacity of our indigenous grasses brought to light the fact that there was one grass which surpassed all others tested under Pretoria conditions so far as carrying capacity and ability to withstand continuous grazing were concerned. This was a stoloniferous *Digitaria* obtained from the edge of the Kalahari, near Vryburg in Bechuanaland. This grass was so outstanding that special attention was devoted to determining its distribution in the Union. By means of the Botanical Survey not only was its distribution ascertained, but a large number of different strains of this grass and in addition an equally large number of undescribed stoloniferous Digitarias were brought to light, from all the grassland areas of the Union. These were established at the Pretoria pasture stations where they are now under investigation. Some of the more promising have been transferred to other Government stations and Agricultural Schools in different parts of the country for further tests and for distribution amongst farmers. Some very promising strains have been obtained which are eminently suitable for cattle and sheep pastures and also for hay.

The disadvantage with regard to the establishment of these *Digitaria* pastures was that they had to be laid down from vegetative shoots owing to the non-production of seed. Seed-setting varieties have now been secured, however, and a trained plant breeder, Mr. de Villiers, is devoting special attention to this problem at Pretoria.

Also at Grahamstown, Mr. Liebenberg, the botanist in charge of the Botanical Survey there, has given attention to seed production in the Digitarias and has met with considerable success.

In the eastern grasslands in Natal, Staples and Fisher at the School of Agriculture, Cedara, have also devoted considerable attention to pasture problems since 1921. Staples has dealt with studies of veld management with special reference to burning, while Fisher has explored the possibility of improved pastures. Working with grassland commonly known as "sourveld," Staples found that burning during the dormant period of growth had a beneficial rather than an adverse effect on the composition and the quality of the grazing. He found that the growth of red grass (*Themeda triandra*) was encouraged, and the palatability of the herbage was improved. In order to obviate soil erosion as much as possible burning every second year was recommended. The burning was best done just before the early spring rains. If the grass was burnt when it was in an active state of growth, deterioration quickly resulted, the red grass was killed and its place was taken by undesirable grasses. On the other hand when the veld was allowed to remain unburnt for more than two years veld deterioration also set in, through the accumulation of dead grass which did not easily decay and which rendered the grazing unpalatable.

Being impressed with the limited carrying capacity (1 ox to 5 to 6 acres) of the natural veld at Cedara, Fisher has devoted considerable attention to improved pastures, using mainly kikuyu and *Paspalum* for this purpose. He has compared the yield in milk from natural veld and from improved pastures at Cedara. He found that one acre of natural grazing produced from 100 to 130 gallons of milk, and that such veld failed to give any increase in milk yield by the addition of fertilizers, whereas when kikuyu and paspalum were heavily fertilized the grasses responded immediately and yields of milk increased enormously. Further, in the veld trials there was little gain in the live weight of the cows, while from the improved pastures it was substantial. Over a five-year period yields of milk varying from 177 gallons to 547 gallons per acre were obtained from the paspalum pastures while yields from 661 gallons up to 1,215 gallons of milk per acre were secured from the kikuyu grass pastures.

At the School of Agriculture at Potchefstroom, in what is known as our middle veld or mixed grasslands, pasture investigations have been conducted by Saunders since 1927, mainly relating to veld management, the effect of fertilizers on different indigenous pasture grasses, and breeding work on *Chloris gayana* and on *Sorghum* species. In the former case the object is to breed frost-resistant strains, and in the latter to produce, if possible, perennial non-poisonous types for hay purposes.

Briefly, the results obtained by Saunders with regard to burning were :— Annual burning without any further treatment had a very bad effect on the veld. *Themeda* tended to disappear while *Aristida* increased. There was also a marked increase in the area of soil not covered by grass, and there were clear signs that erosion was being induced.

In the veld grazing experiments the best results were obtained by resting the veld in summer and grazing during the winter months. Annual cutting for hay had a depressing effect on *Themeda* and encouraged *Cymbopogon* and *Elionurus*. A similar effect was observed when the veld was left completely untouched. *Themeda* at first increased considerably, but its place was later taken by *Cymbopogon*. Continuous grazing of the veld either by sheep or cattle invariably led to dominance by *Aristida*.

The application of fertilizers to the veld gave a small increase in the amount of hay, but did not justify the expense or labour.

Brief mention has been made above to the work of Henrici on the mineral

deficiencies of some of our pastures. At first Henrici investigated the physiology and chemical composition of the more important grasses of Bechuanaland—a semi-arid grassland type. Her work on the physiological side broke entirely new ground so far as South Africa is concerned and gave us valuable information on osmotic values, transpiration and chlorophyll content of the Bechuanaland grasses. On the chemical side Henrici added considerably to our knowledge of the phosphorus content and its variation in the composition of the Bechuanaland grasses. After this, Henrici made comparative studies (1926-27) of the phosphorus content of grasses on the High Veld, and showed clearly that these grasses were poor in phosphorus except in early spring. During winter the phosphorus content was extremely low.

From grassland Henrici next turned her attention to desert shrub pasturage of the Upper Karroo, carrying out her investigations at the Veld Reserve at Fauresmith. Here research has been conducted on the carrying capacity of Karroo shrublets, on their composition and feeding value, on their physiology, and on the germination of their seeds. Briefly, the results up-to-date indicate that mixed veld, that is to say mixed bushes and grass, offer the best and most reliable grazing. With shrublets or bushes alone carrying capacity and weight increase by sheep do not always go hand in hand. Some bushes offer food for a long time, but the sheep soon tire of them, only nibble them, and do not increase in weight, although the plot remains in perfect condition. On the other hand, other bushes are grazed down quickly without having time to recover, but the increase of weight of the sheep is enormous. Taken on the whole, Karroo bushes are poor in protein, but rich in minerals, the phosphorus and calcium being considerably higher than in the grass-veld.

Henrici finds that Schimper's theory that plants of xerophytic morphology transpire but little does not hold good for South African plants, and that probably the idea of the modern Russian School of Physiologists that xerophytic plants in the sun can show transpiration as high or higher than European mesophytes has to be accepted with some modification. The drought resistance of the Karroo plants has no connexion with the rate of transpiration, as many of the most drought resistant small bushes all show high transpiration.

The seed germination investigations have revealed the fact that seeds from a large number of Karroo shrublets require a long period of after-ripening before a good germination is secured. Many seeds need 3 to 4 months of after-ripening.

Up to the present nothing is known in South Africa of the digestibility of desert shrub pasturage and work to elucidate this is now in progress at Fauresmith.

Until quite recently little research or experiments were devoted to our pastoral problems by those outside the Department of Agriculture, but within the past seven years there has been a general awakening in this respect and some excellent work on the effect of fertilizers on intensive grazing of natural veld and artificial pastures has been carried out by Hall and Moses on behalf of African Explosives and Industries, Ltd. Hall has shown that the application of fertilizers has in some cases improved the carrying capacity of the veld up to 300 per cent, especially those containing phosphates and nitrogen. Hall has also shown that potash and lime increase the palatability of the pasture to a marked degree and that less selective grazing occurs when complete fertilizers are used. He also found that the chemical composition of the pasture was definitely improved both as regards protein and mineral content through the application of suitable fertilizers, but he has been careful to point out that it may not always be economical to fertilize veld of poor quality. Moses has shown that for the coast belt of Natal, Kikuyu grass under proper management will provide pastures of a carrying capacity and feeding value which compare favourably with those from good pastures from other parts of the world.

Credit must also be given to the recent work of Hector and his students of the University of Pretoria, and in particular to the observations and deductions of Rowland on plant succession in relation to grazing. Rowland has shown that the most potent cause of veld deterioration is uncontrolled grazing in summer on summer-grazing areas.

NATIONAL RESEARCH PROGRAMME.

Up to this time no comprehensive survey of the grazing problems of the country had been undertaken, nor had it been possible to organize pasture research on national lines, but during the past few years a great change has taken place. Veld preservation and pasture research have now become the chief concern of the State's agricultural policy. It has, therefore, become possible to carry out a preliminary survey of the grazing problems of the country in relation to farming practice. This work has been very ably carried out by J. W. Rowland and J. D. Scott, pasture research officers in the Department of Agriculture, working under my direction. It is now possible to lay down and organize the research work required on broad national lines. As a result of investigations by the above-mentioned officers, as yet unpublished, it can be briefly stated that our main problems will be concerned with :—

(1) A general decline in the carrying capacity of the veld due to faulty grazing management.

(2) The building up of an organized animal industry based on the development of the natural pasture potentialities of the country.

As yet there is no fundamental knowledge relating to grazing management in any of our natural veld types, and a great field for research presents itself here.

At present, owing to lack of knowledge, veld types which are naturally those best suited to extensive farming are being used intensively and vice versa. Only through research and experiment will it be possible to determine the role of the biotic factor in the different grazing areas and thereby secure the best results. This has now been rendered possible largely through the impetus which has been given to veld management and pasture research through the Union Government's scheme for combating soil erosion—a national menace of vast proportions brought about largely through overstocking, faulty cultivation and veld burning.

Under this scheme, in addition to facilities being given to the farming community and others for the building of dams and conservation of water generally, special provision has been made for research on a generous scale regarding veld management and pasture improvement. Veld management and pasture research stations are now established in the different grassland areas where the local problems can be investigated in situ. In addition, the different Universities throughout the country are being encouraged to assist in the matter by the provision of Government grants towards research in the field and for the special training of workers in plant ecology. This latter policy has already yielded valuable results and much more can confidently be expected.

It can now safely be said that steps are being taken to secure for the Union the necessary fundamental information relating to its pastoral resources on a scale commensurate with the importance of this matter, and while we realize that many of our problems are peculiarly our own and must be solved in the Union, we also appreciate to the full the immense assistance which can be obtained from contact with workers overseas.

HAY AND FODDER GRASSES AND LEGUMES IN THE UNION OF SOUTH AFRICA.

A. R. Saunders.

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The live stock industry in South Africa is dependent on natural pasturage primarily, and in proportion to the area of the country and the amount of arable land the production of fodder crops is relatively small. It is being increased, however, to meet the requirements of an enlightened and progressive live stock policy, and the probability is that in the not very distant future much of the land which is to-day carrying cereals and other crops will be put down to fodder crops or artificial pastures.

In dealing here with the subject of fodder crops, no reference will be made to grasses and legumes which are utilized for grazing in the first instance, nor to roots and cereals, except to mention that most of the ensilage used in the Union is made from maize and that approximately 150,000 tons of oat hay and a considerable quantity of peanut hay are produced annually. For purposes of convenience, the subject matter under discussion is best divided into two sections, namely, (1) grasses and (2) legumes.

The Chief Grasses.

Teff. *Eragrostis tef* Trotter.

The main gramineous hay crop of the Union is teff. Based on the average of the five year period 1924-29, the areas under this crop in the four provinces are as follows:

Area in morgen*

Cape.	Natal.	Transvaal.	Orange Free State.	Total.
4,113	5,700	84,207	46,595	140,615

Teff was introduced into Natal in 1887 from the Royal Botanical Gardens at Kew (**4, 5**). It apparently proved a failure as a cereal, but gave much promise as a hay crop, without, however, attaining agricultural status. In 1903 it was re-introduced from California by Burtt-Davy, and now occupies a larger morgenage than any other hay crop. Nearly two-thirds of the crop is grown in the Transvaal, especially the districts of Standerton, Bethal, Heidelberg, Ermelo and Middelburg. The leading districts in the Orange Free State are Kroonstad, Heilbron, Frankfort and Senekal. In Natal, teff is of importance on the Uplands only, including the districts of New Castle, Estcourt, Dundee and Utrecht, while in the Cape Province it is more or less confined to the north-eastern section and chiefly the districts of Mount Currie and Matatiele.

The distribution of teff follows that of maize fairly closely except that it does not extend as far into the extreme areas of high and of low rainfall. It requires relatively favourable moisture conditions, particularly at the time of germination, and is therefore an uncertain crop in parts receiving less than 24 inches of rain.

* 1 morgen = 2.11654 acres = 0.8565 hectare.

On the other hand it is subject to lodging under a high rainfall; hence the bulk of the crop is produced in the summer rainfall belt* of 25 to 30 inches. The average yield is approximately 1.5 tons per morgen, though returns of 4 to 8 tons are not uncommon (**1**).

Owing to its short growing period and ease of cultivation, teff fits in admirably as a rotation crop with maize, in that sowing can be delayed until the maize crop is planted. From early sowings two and occasionally three cuttings may be obtained, but the rule is one only and a partial second, which is either grazed off or ploughed under. There are few crops as easy to cure for hay as teff by virtue of its fineness of stem and leaf. For this reason also chaffing is unnecessary when feeding the hay to stock, and if the crop is cut at the right stage and properly cured the fodder is palatable to all kinds of stock.

On the other hand teff is not without undesirable features. In the first place the fact of its being an annual implies a higher cost of production than with the same yields from a perennial. Secondly, complete failures often occur through drought as the crop is exhaustive of soil moisture. Following a heavy crop of teff the soil is not infrequently too hard and dry to plough, necessitating a lie-over till the commencement of the next rainy season, when maize planting is at hand and the work of soil preparation has of necessity to be crowded into a comparatively short space of time. In common with other annual grasses, teff has the disadvantage also of not contributing materially to the maintenance and building up of soil humus as is the case with perennial grasses. This is a matter of the greatest importance to the farmer and technical agriculturist alike, for the humus content of South African soils is notoriously low and becomes rapidly exhausted under conditions of cultivation.

From the point of view of animal feeding there is the further difficulty that teff does not solve the problem of providing a protein-rich feed for the winter months when the natural pasturage has little nutritive value. Its protein content is not high, being usually in the neighbourhood of 6 to 7 per cent (Table 1), of which only about 50 to 60 per cent is digestible (**15**).

A large amount of agronomic information relating to teff production has been procured and breeding experiments are in progress at the University of Pretoria with the object of enhancing yields, increasing the percentage of leaf and effecting various other improvements. Superior types could doubtless be evolved, but they are not likely to prove ideal and it would seem sound policy to search for some more suitable crop and encourage the greater production of legumes.

Common millet or "Boer manna." *Setaria italica* Beauv.

Prior to the advent of teff this was the chief hay crop in the summer rainfall area. For the period 1921-26 the average annual morgenage amounted to about 30,000, three-fourths of which was in the Orange Free State. Since 1924 the cultivation of millet has steadily declined (this decline being accompanied by an increase in the morgenage under teff), and although no statistics are available it is doubtful if the area now exceeds 20,000 morgen.

The same objections apply to common millet as to teff, except that it is able to establish itself more readily than the latter under adverse conditions of soil and moisture. It is therefore used for "taming" new lands and as a smother crop for weeds. By reason of its rapid growth and quick maturity, it is usually sown late as a catch crop, averaging about 2 tons per morgen in yield. The hay cures readily

*Summer rainfall area = that part of the country receiving the greater portion of its rainfall during the months October to March.

and is suitable for cattle and sheep, but not for equines unless cut early. Its feeding value is relatively low and as a hay crop millet is likely to become of less importance as the production of leguminous hay and other more valuable grasses increases. At present no extensive investigations seem justified or are in progress.

Sudan grass. *Sorghum Sudanense* Stapf.

Although a native of Africa, Sudan grass was introduced into the Union from the United States in 1914 (**13, 14**). Its value has not yet been fully appreciated, but it is nevertheless replacing teff and millet in the drier sections of the Maize Belt,* such as the Western Transvaal and the Northwestern Orange Free State. Good crops of Sudan grass are frequently obtained under circumstances where teff and millet have completely failed.

The most undesirable feature of this grass is its coarseness and, at times, its difficulty of curing. Yields generally range from 4 to 10 tons per morgen. Factors militating against its increased production are the danger of hydrocyanic acid poisoning and the fact that the crop is subject to bacterial blight during wet seasons. The danger of poisoning has been somewhat exaggerated, for in any case the hay can be fed to all kinds of stock with safety.

For reasons already advanced in connection with teff, Sudan grass would be of much greater value if it were a perennial, and with the object of breeding such a type extensive breeding experiments have been started at Potchefstroom. Crosses between Sudan grass and various other sorghum species have been made, but whether or not a suitable perennial form will ultimately be obtained is too early to state. However, improvement will be effected insofar that some of the new types which are in the course of being bred will be definitely more leafy and less coarse of stem than Sudan grass.

Rhodes grass. *Chloris gayana* Kunth.

Rhodes grass affords another instance of a species which has attained greater prominence in other countries than in its natural home. In spite of being introduced into cultivation as early as 1895 by the late Cecil Rhodes (**19**) its production has not increased to any noticeable degree.

As regards palatability and chemical composition, Rhodes grass compares very favourably with other hay grasses of the Union. Yields usually exceed those of teff by a considerable margin and the hay cures almost as readily The main reasons why it does not find more favour are doubtless its susceptibility to injury by severe frost and the fact that on the Highveld† generally it behaves more as a biennial than as perennial. Young seedlings not properly established before frosts set in are often winter-killed. The crop as commercially grown is, however, very variable in this respect and individual plants have been observed to withstand cold very much better than the remainder and to persist for a number of years.

From such plants several hundred selfed selections have been made at Potchefstroom. Crosses between some of the most promising of these selections and cold-resistant wild forms are to be effected shortly, and it seems not impossible that strains could be produced which would be well adapted to the greater part of the summer rainfall area. Agronomically such types should prove of the greatest value as semi-permanent crops in rotation with maize, and the ultimate result hoped for is that they should replace teff wherever possible.

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*Main Maize Belt or Triangle, = that portion of the Transvaal and Orange Free State Highveld which lies between the 25 and 35 in. rainfall lines.

†Highveld = the inland plateau (excluding the Karroo) with an elevation of more than 4,000 feet. Subject to heavy frost.

Napier fodder. *Pennisetum purpureum* Schum.

This grass is a native of tropical Africa and was first brought to the attention of the Rhodesian Department of Agriculture in 1908 by Mr. E. G. Kenny and Colonel Napier, the grass subsequently receiving its popular name after the latter.

Napier grass is a coarse perennial reaching a height of 6-10 feet in the Union. It flourishes along water courses and on low-lying moist but well-drained soils. While the young growth is readily eaten by stock, the hay is very coarse and fibrous and presents great difficulty in curing. The grass is therefore best turned into ensilage or utilized as a soilage crop, for which purpose it answers excellently as it grows out rapidly after each cutting. In general at least, two cuttings for ensilage can be obtained per season and yields of 40 tons per morgen are not uncommon. Experimental work is limited to trial plantings in different areas, and, as the grass does not mature seed in the Union, no breeding work is being done.

'nYati or pearl millet. *Pennisetum spicatum* Wild.

Although a native of Western Asia, pearl millet (commonly known as "Kaffir manna") has been cultivated for its grain since time immemorial by native tribes in Southern Africa (**2, 13**). Its drought resistance makes it an excellent crop for dry areas, and if sown thickly and cut early the hay is palatable and nutritious, although somewhat coarse and difficult to cure. 'nYati exhausts the soil, but has the merit of being one of the few gramineous crops which are immune to *Striga lutea* Lour., and on this account deserves greater attention in areas infested with this parasite.

OTHER GRASSES.

A wide range of other grasses has been tried in South Africa, the majority with slight success. The indigenous Guinea grass (*Panicum maximum* Jacq.) is met on a few farms and *Cenchrus ciliare* Link. holds out some promise in dry areas. Exotics which deserve mention are *Paspalum dilatatum* Poir., *Dactylis glomerata* L., *Festuca arundinacea* Schreb., and the ryegrasses (*Lolium* spp.), but they are grown primarily for grazing purposes. Beyond adaptation trials little experimental work is being done on them.

COMPOSITION OF SOUTH AFRICAN GRASSES AND LEGUMES.

In Table 1 are given analyses of South African grasses and legumes. The number of such analyses available is regrettably limited, and they should be taken to represent individual samples rather than fair averages.

Table 1. Composition of some South African grasses and legumes.

Crop.	Moisture Per cent.	Percentage of dry matter.					Authority.
		Ash.	Crude protein.	Ether extract.	Crude fibre.	Carbo-hydrates	
GRASSES :							
Teff hay.	8.2	7.3	6.5	1.2	37.9	47.1	Vipond (**21**).
Boer manna hay..	7.4	7.4	5.4	1.6	39.6	46.0	,,
Sudan grass hay	3.5	5.8	4.8	1.3	36.9	51.2	Melle & Stent (**14**)
Rhodes grass hay	9.0	9.6	10.1	1.4	46.7	32.2	Stent & Melle (**19**)
Napier Fodder hay	7.6	8.3	6.4	2.2	33.0	50.1	Skibbe & Sellschop (**19**)
LEGUMES :							
Lucerne hay (1)	8.8	9.2	19.4	3.5	30.5	37.4	Marchand & Smit (**12**).
(2)	8.0	9.7	16.8	2.6	37.7	33.2	Vipond (**21**)
Cowpea hay	8.2	6.9	14.4	2.6	33.2	42.9	,,
Soybean hay ..	11.3	8.1	17.4	5.9	25.1	43.5	,,
Velvet bean hay	9.3	8.6	14.7	2.8	30.4	43.5	,,

The Chief Legumes.

In few countries is the need for legumes in animal feeding greater than in South Africa because of the almost total absence of leguminous plants in the natural pasturage. Yet apart from lucerne under irrigation the proportion of legumes to cereal and other crops is disturbingly small. Our crop farming is in this respect badly unbalanced and in the interests of permanent agriculture an increased production of legumes calls for urgent attention.

Lucerne. *Medicago sativa.*

By far the most important leguminous hay crop in South Africa is lucerne, of which about 80 per cent is produced in the Cape Province. The distribution of lucerne is shown by the following figures:

Morgenage under lucerne, average 1924-29.

Cape.	Natal.	Transvaal	Orange Free State	Total.
69,095	1,066	5,706	9,591	85,458

The bulk of the crop is grown under irrigation and mostly in localized areas constituting irrigation schemes. In the Cape, the leading districts are Uitenhage, Cradock, Oudtshoorn, Middelburg, Kenhardt, and Victoria West. Potchefstroom, Lydenburg, Pretoria and Ventersdorp are the chief lucerne districts in the Transvaal, while in the Orange Free State Phillipolis, Vredefort, Rouxville, Smithfield and Bloemfontein head the list. The crop is of minor importance in Natal, only the districts of Weenen and Umvoti showing a fair production.

Although phenomenally good yields have been reported in many instances, the average is but little over 2 tons per morgen. The low average yield is in part due to unsuitable soils and the want of fertilizers. With improvement in farming methods there seems no reason why lucerne should not be extensively cultivated on non-irrigated land in parts of the country with a relatively favourable rainfall. Individual farmers have practised such cultivation successfully in the Maize Belt and good results have also been obtained in the winter rainfall area (**11**).

As a rule no artificial inoculation is necessary, although in some localities of the Lowveld it is essential if a good crop is to be obtained. Varietal trials have been conducted at various centres, and those which have given the best returns and which are generally grown are Provence, Hunter River, and, to a less extent, Chinese. An appreciable quantity of seed is produced annually for domestic consumption and export.

The main centre for lucerne investigations, especially under irrigation, is the Grootfontein School of Agriculture at Middelburg, Cape Province. A wide field is covered, including transpiration and duty of water experiments, effect of stage of cutting on yield and the length of life of the crop, methods of irrigation, seed production, utilization of the crop by means of the grazing animal, prevention of hoven and various other problems. One phase of experiment which has been somewhat neglected is improvement by breeding, but work along these lines is contemplated and will probably be commenced shortly.

Cowpeas. *Vigna sinensis* and *V. catjang.*

The cowpea is represented by numerous indigenous types and imported varieties. Its value was recognized by the native inhabitants of the country long before the arrival of the European, and it has without doubt been under cultivation for many centuries. The natives observed its beneficial effects on succeeding grain crops and in consequence probably practised the first system of crop rotation in South Africa.

At present the cowpea or "Kaffir bean" is still extensively grown in native areas as a green vegetable and for its seed, and is rapidly finding favour with European farmers as a hay crop in the drier portions of the Maize Triangle, especially the Western Transvaal and the Northwestern Orange Free State. The crop lends itself well to cultivation in these parts because of its drought resistance and ability to germinate in a relatively dry soil. A factor which limits its production in the main Maize Triangle is susceptibility to *Phyllosticta* leaf spot and anthracnose. For this reason also it is unadapted to the Mist Belt and coastal areas (**8**). A universal objection to the cowpea amongst South African farmers is the fact that nearly all varieties at present grown are decumbent and therefore require much labour in harvesting for hay.

Many sheep farmers grow cowpeas for grazing during the lambing season, and it is claimed that when so utilized the crop is unsurpassed as a milk producer and for the general improvement of the health of the flock. As a green manure crop the cowpea has few equals, often giving a response where no other crop will. At Potchefstroom maize following cowpea green manure has yielded 35 per cent more than maize continuously, based on the four-year average 1930-34.

Breeding experiments with a view to evolving upright, disease-resistant strains were started at Potchefstroom in 1929, and some 500 F_4 and F_5 progenies from nearly fifty different crosses are available for further selection. Most of this material is still in a state of segregation and no new types could be distributed for at least another two or three years. Results to date are, however, most encouraging and several of the new selections possess all the main characteristics desired. Concurrently with the breeding work genetical investigations have been conducted, and the data accumulated present a considerable contribution to our knowledge of the genetics of *Vigna.*

The soybean. *Glycine hispida.*

Notwithstanding its introduction as early as 1903 (**3,16**), the soybean is still unknown to the majority of South African farmers. Numerous varieties have been tried (**7,16**) and analyses made to determine oil content. Results have in the main been fairly satisfactory, especially as regards the percentage of oil. Turner (**20**) reports a higher oil content for South African grown soybeans than for Manchurian, and claims that " the continuous and brilliant sunshine of the South African climate contributes to a high percentage of oil." Analyses at Potchefstroom have revealed an average oil percentage ranging from 17 to 21 per cent, depending upon the variety.

It is perhaps unfortunate that nearly all the emphasis has been put on the potentialities of the soybean for oil production in South Africa and that its value as a hay crop has to a large extent been ignored. The hay is admittedly coarser than that from cowpeas and yields are not as high, yet the soybean should find an important place in parts of the country where the climate is too moist for cowpeas. A fundamental difficulty is that farming methods need to be much improved before the successful production of soybeans is possible. This crop requires better seed bed preparation and more effective cultivation than is generally practised for maize, besides favourable moisture conditions at the time of germination. It does not endure drought as well as the cowpea ; hence its future lies in the summer rainfall belt of 25 - 35 inches.

Artificial inoculation is generally necessary, although the differences in yield between inoculated and non-inoculated beans are sometimes negligible. In regard to seed production a serious drawback is that, in the Transvaal and Orange Free State at least, all the well-known varieties shatter severely at maturity. Breeding experiments were started at Potchefstroom in 1926 in an attempt to overcome this obstacle and have met with gratifying success. Several new and virtually non-shattering strains are being increased for seed distribution and the prospects of their finding an important position in South African agriculture are very good, provided prices are remunerative.

Investigations to determine the effect of climate, soil and fertilizers on composition are being conducted by the Chemistry Section of the Potchefstroom School of Agriculture and valuable information has been obtained. Research is also in progress on the inheritance of oil and protein content. High negative correlations between the percentage of these constituents appear to be the rule and the mode of inheritance can best be explained on the bases of quantitative factors.

Velvet beans. *Stizolobium* spp.

Dolichos lablab.

The cultivation of these crops is practically limited to the Lowveld* for the reason that the growing season on the Highveld is too short. Excellent yields have been reported by some farmers and both crops justify more extensive production in suitable localities. Experimental work on them is confined to yield and adaptation tests at a few Stations.

Vetches.

Vicia sativa and *V. villosa* are the types commonly grown. Conditions for their cultivation are in the main not suitable in the summer rainfall area except portions of Natal and the North-eastern Cape Province (**10**). They are therefore of greatest importance in the winter rainfall area of the Western Cape Province.

Clovers.

Very few native clovers occur in South Africa and none appear suitable for cultivation. Numerous attempts at establishing the Old World clovers have met with little success, with the possible exception of *Melilotus*. Climatic conditions are unfavourable to their production and the replacement of lucerne by clover under irrigation does not seem justified.

Other Legumes.

Many other legumes well-known in Europe, America and elsewhere have been introduced and tried, but none have gained a foothold. The list is a fairly long one, but the following might be mentioned: lespedeza (*Lespedeza striata*), sainfoin (*Onobrychis* spp.), Kudzu (*Pueraria thunbergiana*), lupins and serradella (*Ornithopus sativus*.)

*Lowveld = inland areas having an elevation of less than 3,000 feet and where the incidence of frost is rare or slight.

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OUTLINE OF PASTURE WORK.

By J. W. Rowland.

The facilities for carrying out the work outlined below were granted by Dr. I. B. Pole Evans, who has been responsible for the inauguration of a National Scheme for pasture research and reclamation of damaged areas in South Africa.

It is considered likely that the natural veld will be the main source of food for livestock in the country for many years to come. Artificial pastures will be used to an increasing extent, especially in the better watered regions. In all probability, artificial pastures will be used mainly to supplement the natural vegetation at periods when it is either of little value or susceptible to damage by grazing.

Veld research is being concentrated chiefly on the following aspects :—

(1) Methods of management whereby the veld is stabilized at a useful level of productivity.

(2) The periods of value, and the periods of shortage in veld production.

(3) The periods of critical growth when the vegetation may be said to be vulnerable or particularly susceptible to damage by grazing animals.

(4) The limits of botanical composition between which the veld can be changed by variations of grazing treatment.

Correct management can undoubtedly increase the period of usefulness of the natural veld considerably. The problems vary widely in the different parts of the Union. In the sweeter, more arid regions, control must take the form of a limitation of stock numbers, and the provision of facilities for resting the veld during critical periods. The significance of different periods of rest is being investigated, together with tests of carrying capacity. On the sour velds, difficulties in achieving grazing control are ascribed mainly to the following factors :—

(1) Wide variations in growth rate.

(2) The rapid decline in palatability and feeding value of the herbage as it approaches maturity.

These two factors tend to intensify the evils of selective grazing. In order to eliminate this selective grazing, which can so easily cause steady deterioration, systems of subdivision into camps of different sizes have been devised ; during periods of rapid growth, small camps are grazed rotationally, and during periods of slow growth, large camps are used. The relative sizes of the camps must ultimately be determined by (1) variations in the growth rate during the summer ; (2) the value of the herbage at the different seasons ; (3) the length of the periods of rapid growth and of slow growth respectively.

Simultaneously with this line of research on veld, artificial pastures are being investigated to find the seasonal grazing value of each type. When this is known it will be possible to select those artificial pastures which provide the largest quantity of suitable feed at the seasons of the year when the natural veld is either susceptible to damage or of no value for grazing.

THE INITIATION OF BREEDING WORK ON HERBAGE CROPS IN SOUTH AFRICA.

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The meagre returns from farming especially during the years of the depression and the failures of cereal crops through periodic droughts have necessitated a survey of conditions pertaining to agriculture in this country. Apart from certain areas where the production of fruit, tobacco, cereal crops, sugar cane, etc. is successful, the natural endowments are such that a very large portion of the country is more suited to the production of animals and animal products.

From a pasture point of view, the climate in South Africa is unsuitable for many grasses introduced from Europe and America, and experiments have shown that they are successful only in certain localized areas. The cultivated grasses of agricultural importance in South Africa to-day are mostly indigenous to Africa. By means of the Botanical Survey, under the control and direction of the Chief, Division of Plant Industry, a large and valuable collection of indigenous grasses has been made from all parts of the country. The results obtained from these grasses are considered to be of the utmost economic and scientific importance to South Africa, and it can safely be suggested that such a survey could profitably be followed by all countries of the world where work of this type has not previously been undertaken.

Perennial species of the genera *Digitaria, Pennisetum, Echinochloa, Urochloa, Panicum, Chloris, Setaria* and others are considered to be our most important hay and pasture grasses. In each of these genera, numerous species have been collected over a wide range of soil and climatic conditions. From this material it is hoped to breed suitable hay and pasture grasses for the various summer rainfall areas of the country. As regards winter pastures, we have unfortunately not yet found a very suitable indigenous or exotic grass, which is sufficiently drought-resistant to be of general importance. In this respect several European grasses are being grown where climatic conditions are suitable, and in some areas, winter cereals are utilized for winter grazing, especially by sheep farmers.

It is probably not necessary to enumerate the characteristics desired in strains for each particular area, but it may be mentioned that the strains of grasses required in the widely different areas vary not only because of different soil and climatic conditions, but also on account of the different farming systems. Desirable characters such as high yield, good carrying capacity, palatability, high nutritional value, disease, drought and frost resistance, large production of viable seed, aggressiveness, etc., have to be taken into consideration, and naturally the characters required for each area will depend upon the purpose for which the grass is intended, i.e. for pasture, soiling, hay or silage.

Attention up to the present has been given mainly to the *Digitaria* species, and a brief discussion of the more salient features of this group, as well as some of the results obtained, may be of interest. In this genus we have annual and perennial species. In the perennials many stoloniferous or tufted, and to a lesser extent rhizomatous types, are found. In each of these types wide variations are exhibited, ranging from very low or prostrate to upright tall and robust plants, varying in rate of growth, drought, disease and frost resistance, nutritional value (mineral and protein content especially), size, shape and texture of leaves, rate of seeding, etc.

Fig. 1. Digitaria smutsii. A tall tufted type.

Fig. 2 Digitaria argyrograpta. A small tufted type

Fig. 3. Digitaria swazilandensis. A low growing stoloniferous type.

Fig. 4. Digitaria polevansii. A tall stoloniferous type.

Special attention has been given to some of the more promising species and strains in the Digitarias, mainly on account of their high carrying capacity, drought-resistance, and fairly high nutritive value, both during the growing season and in the dormant stage. The latter characteristic is of great importance to South Africa, since the analyses made by the Divisions of Plant Industry and Chemistry have shown that our grasses are rather low in mineral content, especially in phosphorus. During winter when the veld is dormant, the mineral content still further decreases and bone meal is often fed to supplement this phosphorus deficiency. The importance therefore of having grasses such as some of the Digitarias which will retain their mineral content in the dormant stage to a relatively higher degree than our general veld grasses will be appreciated.

The technique of hybridization has been satisfactorily completed, and numerous hybrids have been obtained. Some of the Digitaria strains collected are natural hybrids, in which complex segregation occurs; certain segregates appear to be highly promising. In addition to the crosses, numerous selections for the improvement of these grasses along certain lines have also been made.

A wide variation in seed setting in the Digitarias has been found. Some produce no seed, whereas in others the percentage of florets which set seed varies from 4 to 80. From this material it is hoped in the near future to breed satisfactory strains which can be propagated by seed instead of by runners or roots, as is being done at present.

An interesting observation was made on the germination of the seeds. Most of the seeds of species collected in areas where the rainfall normally exceeds 20 ins. per annum germinate readily immediately after harvesting. In species collected in the more arid regions of the country where the rainfall is normally 15 ins. or less per annum, the seeds do not germinate soon after harvesting. However, germination tests carried out at monthly intervals indicate that there is a gradual increase in germination of these seeds, reaching 5 per cent at the end of one year. On the other hand, the removal or partial removal of the pericarps immediately induces germination of all healthy seeds.

A suggestion may be made regarding the possible biological significance of the germination of seed from arid areas, particularly as regards reproduction and dispersal in their natural habitat. In these parts the soils are generally very sandy in nature, sand dunes and shifting sands being sometimes found. The rainfall is erratic and prolonged droughts frequent; summer day temperatures are usually very high, whereas in winter the minimum temperatures are relatively low. The plants and seed in these areas are therefore often subjected to rather severe environmental conditions. The variation in the dormancy period of the seeds protects the species against adverse conditions. The germination of one season's seed crop is probably spread out over a long period of time, and the chances of obtaining favourable conditions for some of the progeny is greatly increased. Furthermore, the caryopsis is covered by fairly hard glumes, valve and pale; these outer coverings will to some extent resist injury to the seed by windblown sand particles while it is being carried some distance from the parent plant. Moreover, immediate germination of all healthy seeds is obtained by partial removal of the pericarps and since this would probably occur in time by abrasion of moving sand particles, provision in this case is possibly made for the early germination of a number of seeds, when favourable conditions do occur. It is conceivable, however, that many seeds may

be killed by excessive or continued abrasion if favourable conditions for germination are unduly delayed. Nevertheless, one is impressed by this adaptation for reproduction and seed dispersal under severe environmental conditions.

Fig. 5. Digitaria spp. Strain from N'Hamba. A rhizomatous type, showing a few exposed rhizomes to the right.

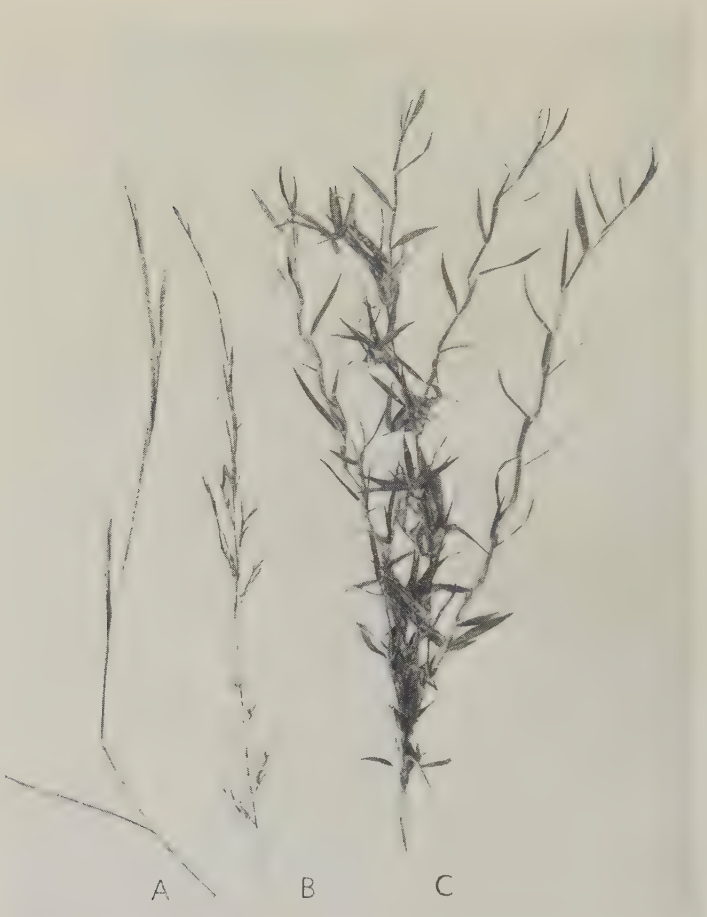

Fig. 6. Different types of stolons showing :—

A. (Digitaria polevansii) an unbranched stolon with long internodes.

B. (Digitaria swazilandensis) a branched stolon with very short internodes.

C. (Digitaria spp. Strain from Pitsanie) a branched stolon with internodes of intermediate length.

EDITOR'S NOTE.

As the publications mentioned in the Introduction to this Bulletin contain good bibliographies on the grasslands of South Africa it has been considered unnecessary to publish a complete bibliography with this Bulletin. The Herbage Bureau will, however, be willing to help any person who may be interested in the literature on any particular point.

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